4.5   Provisional Guidance for the Initial Assessment of Aquatic Effects[*]

4.5.1   Introduction

1.   This document provides guidance for the initial assessment of aquatic effects of High Production Volume (HPV) chemicals with a full SIDS. It is based mainly on the "Guidance Document for Aquatic Effects Assessment" (Ref. 1), which was drafted initially by the Netherlands in the framework of the OECD Hazard Assessment Programme and is now published as OECD Environment Monograph No. 92. This Monograph is based on the reports of the following three Workshops:

-- Application of Quantitative Structure Activity Relationships (QSARs) to estimate ecotoxicity data (Utrecht, 12-14 September 1990) (Ref. 2);
-- Extrapolation of ecotoxicity data to the real environment (Arlington, Virginia, 10-12 December 1990) (Ref. 3);
-- Effects assessment of chemicals in sediment (Copenhagen, 13-15 May 1991) (Ref. 4)

2.   These documents (Ref. 1, 2, 3 and 4) can be referred to whenever detailed information relating to the assessment procedure presented in this document is required. In particular, examples of effects assessments in Ref. 1 are useful for understanding the procedure.

3.   This guidance can be applied to soluble compounds; however, it may not be suitable for elements in the metallic state and for insoluble substances.

4.   Recently, the European Commission has developed the Technical Guidance Document for risk assessment of new and existing chemicals (Ref. 5), that includes detailed guidance for aquatic effects assessment.

4.5.2   Background to Aquatic Hazard Assessment

5.   Environmental hazard assessment is defined as the assessment of the potential of a chemical to cause adverse effects on the environment and/or man. Effects assessment can be defined as the identification and quantification of the potential adverse effects of chemicals on individuals, population or ecosystems by means of laboratory testing or field observations. In an assessment procedure, a comparison is made of the calculated "low risk" concentration where no unacceptable adverse effects on the ecosystem are expected (i.e. Predicted No Effect Concentration, PNEC)[**] and the concentrations that are present in the environment, either measured or calculated (i.e. Predicted Environmental Concentration, PEC).[***] This comparison gives some insights into the risks that the chemical under study poses to human beings or to specific species in any environmental compartment.

6.   Aquatic effects assessment of chemicals is a sequential process that may comprise three stages: initial, refined and comprehensive, where each stage depends on the type and quantity of information that is available.

7.   In the initial aquatic effects assessment on which this document focuses, the impact of the chemical is generally assessed against only one or two representatives from each of three trophic levels by means of short-term toxicity tests; i.e. using primary producers (algae), primary consumers (*Daphnia*) and predators (fish). Refined effects assessments are based on chronic or sub-chronic tests, whereas (semi-) field studies provide the basis for comprehensive effects assessments. Hence, the process of effects assessment goes through stages of imprecise to precise estimations of the concentration that will have no adverse effect on the ecosystem under consideration.

---

[*]   This Provisional Guidance was first prepared by the OECD Secretariat in 1992 based on the results of three OECD Workshops (see para 1). It has been updated to reflect comments by Member countries and agreements reached in the context of the OECD Existing Chemicals Programme up to April 1996.

[**]   Maximum Tolerable Concentration (MTC) is also used synonymously.

[***]   The methods which can be used to calculate environmental concentrations are addressed in "Provisional Guidance of Initial Assessment of Environmental Exposure" (see Section 4.3). Diskettes comprising environmental exposure models for calculation of PECs are also available. It should be noted that all important emission sources should be clearly identified in determining PECs.

8.	Figure 1 presents an example of a scheme for an aquatic effects assessment. It includes not only the initial assessment procedure, but also refined and comprehensive assessment procedures which can be performed when information beyond that in SIDS is available.

9.	Information available through databases and publications as well as from industry should be collected intensively. The data should then be evaluated by appropriate assessors, for example experts in the field of environmental chemistry and toxicology, before they are used for an environmental effects assessment. It is necessary to review the original publication to assess the data collected through databases. In the SIDS work, the data should be generated according to guidelines such as the OECD Test Guidelines using Good Laboratory Practice (GLP) Principles. (Criteria which could be used for evaluation of data is given in Section 3 of Ref. 1. Its summary, with some amendments, is attached as Annex 1 to this document.)
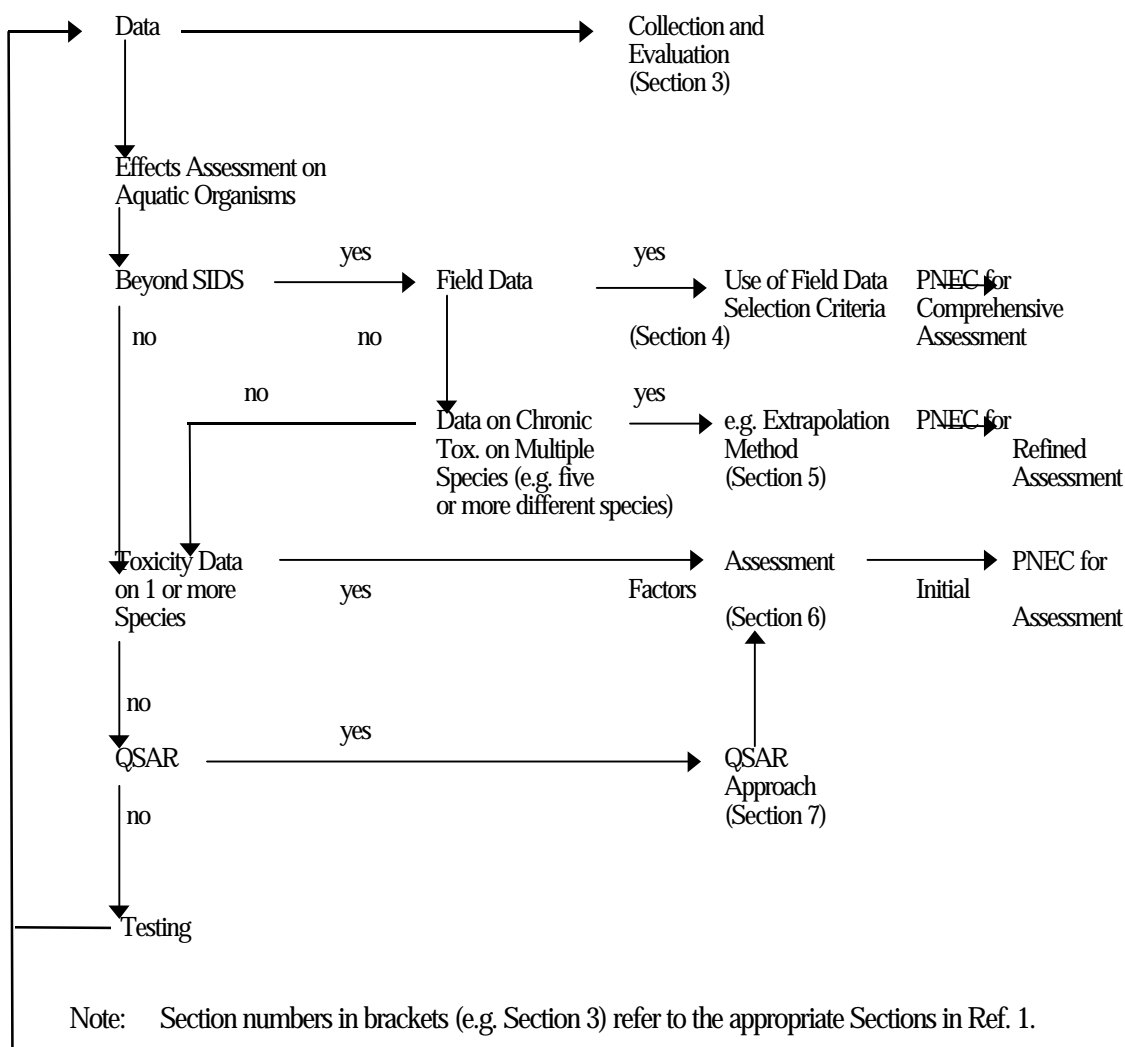
10.	In an initial assessment based on the information obtained in the SIDS work, a set of assessment factors would be applied (see Section 6 of Ref. 1). Also a QSAR approach using physical-chemical properties is applicable for estimating the toxicity of chemicals on a case-by-case basis when no data or only data for one test species are available or when the measured data for a species is deemed to be unacceptable. This approach may also be used for estimating a PNEC value by the application with assessment factors (see Section 7 of Ref. 1). For chemicals where additional information beyond the SIDS are available, the possibility of carrying out higher stages of assessments could be considered [e.g. those based on field testing (see Section 4 of Ref. 1), those by the extrapolation method (see Section 5 of Ref. 1)].

11.	In addition, indirect effects on birds and mammals (see Section 8 of Ref. 1) and effects on benthic organisms (see Section 9 of Ref. 1) of a chemical could be considered depending on the use and properties of the chemical.

12.	When considering refinement of effect assessments or further testing, refinement of exposure assessment should also be considered.

Figure 1 - An Example of an Aquatic Effects Assessment Flow Scheme

1.   Calculation of PNEC

Data ──────────────────────────→ Collection and
                                  Evaluation
                                  (Section 3)

Effects Assessment on
Aquatic Organisms

```
                      yes                          yes
Beyond SIDS  ──────────────→  Field Data  ──────────────→  Use of Field Data   PNEC for
                                                            Selection Criteria  Comprehensive
     no              no                                                         Assessment
                                                            (Section 4)
              no                                yes
                          Data on Chronic  ──────────────→  e.g. Extrapolation  PNEC for
                          Tox. on Multiple                  Method                     Refined
                          Species (e.g. five                (Section 5)               Assessment
                          or more different species)
Toxicity Data  ──────────────────────────────→  Assessment  ──────────→  PNEC for
on 1 or more        yes                          Factors        Initial
Species                                          (Section 6)               Assessment

     no
              yes
QSAR  ────────────────────────────────→  QSAR
                                          Approach
     no                                   (Section 7)

Testing
```

Note: Section numbers in brackets (e.g. Section 3) refer to the appropriate Sections in Ref. 1.

2.   Comparison of PNEC with PEC

- PEC/PNEC < 1 - Chemicals of low current priority for further work

- PEC/PNEC ≥ 1 - Consideration of further work or actions (post SIDS testing, detailed exposure analysis, in-depth risk assessment or further risk management actions)

EXCH\MANUAL\96-4-5.DOC/May 1996

3

4.5.3   Outline of Various Approaches to Aquatic Effects Assessment

Assessment Factors

13.   When only a limited data set is available for an initial assessment of a chemical, such as is the case for most SIDS chemicals, assessment factors can be used to adjust the effect concentration and to estimate a PNEC. However, assessment factors should be applied with care to acute data for substances which are suspected of having a specific mode of action, or which have a high log P_{ow} or which significantly bioaccumulate.

14.   Assessment factors may be used to extrapolate:
-    from the lowest chronic NOEC to the field situation;
-    from concentrations with acute effects to NOECs; and
-    to take account of inter-species differences in sensitivity.

15.   Several sets of assessment factors have been proposed to date. Table 1 summarises proposals from the OECD Arlington Workshop (Ref. 1 and 3), the European Commission (Ref. 5) and ECETOC (Ref. 6). These factors can be modified under certain conditions (e.g. an assessment factor of 1000 in the EU Technical Guidance Document can be lowered to 100 with certain evidence); however, such modifications of the factors are not explained here (please see the references).

**Table 1. Proposed Assessment Factors for Application to Aquatic Toxicity Data
for Estimating a PNEC**

Available information applied	Assessment factor applied to the lowest value (modifications not included)		
	(a) OECD Workshop	(b) EU Technical Guidance Document	(c) ECETOC proposal
One acute L(E)C$_{50}$ for acute toxicity from one trophic level	1000	-	-
At least one acute[****] L(E)C$_{50}$ from each of three trophic levels of the base-set (fish, *Daphnia* and algae)	100	1000	200
One chronic NOEC (either fish or *Daphnia*)	-	100	-
Two chronic NOECs from species representing two trophic levels (fish and/or *Daphnia* and/or algae)	-	50	5
Chronic NOECs from at least three species (normally fish, *Daphnia* and algae) representing three trophic levels	10	10	
Field data or model ecosystems	-	case-by-case	1

[****]   In the EU Technical Guidance Document, "short-term toxicity" and "long-term toxicity" are used instead of "acute toxicity" and "chronic toxicity".

16.		With respect to the OECD Arlington Workshop proposals, a factor of 10 is suggested for each extrapolation step described in para 14. This approach is a modification of a method proposed by US EPA (Ref. 7).

17.		Assessment factors proposed in the EU technical Guidance Document depend on the properties of the chemical and the conditions of testing (such as use of the most sensitive species). In a recent study (Ref. 8), a factor of 100 between the $E(L)C_{50}$ of acute toxicity and NOEC of chronic toxicity has been shown by measured data to be generally justifiable.

18.		ECETOC's proposals are based on comparisons of toxicity data. An acute:chronic ratio of 40, a chronic:ecosystem ratio of 5, and an ecosystem:field ratio of 1 are suggested.

QSAR Approach

19.		When experimental data are limited, QSARs are useful for estimating toxicities of chemicals.
QSARs based on chemical classes are used widely (for example Ref. 9). Proper selection and use of a model for a given chemical can be carried out on a case-by-case basis by using computerised systems such as US EPA ASTER (Ref. 10) and ECOSAR (Ref. 11). QSARs can also be applied to chemicals with a common mode of toxic action, such as narcosis where the mechanism is dependent on a chemical's hydrophobicity (e.g. log P_{ow}). It should be noted that QSARs are valid only for liquids at room temperature and for solids on which data on water solubility are available.

20.		QSARs for chemicals with a common mode of toxic action were discussed in the OECD Utrecht Workshop for two classes, Class I (inert chemicals, baseline toxicity) and Class II (less inert chemicals) shown in Table 2. For a Class I chemical, QSARs may be used to establish whether the experimental toxicity of a chemical agrees with baseline toxicity. If so, then QSAR equations may be used to extend the data on fish, *Daphnia* and algae. For a Class II chemical, estimation by QSAR can be done for acute toxicity to fish although QSARs should not be used when reliable experimental data are available (Ref. 2).

Table 2. Categorisation of Chemicals for QSARs for Approach by Common Mode of Action

Class	Structure	Available QSARs	Reliability
Class I	aliphatic alcohols, aliphatic ketones, aliphatic ethers, alkoxyethers, aliphatic halogenated hydrocarbons, saturated alkanes and halogenated benzenes (only C,H,N,O,F,Cl,Br could be included)	acute and chronic tox. to fish and to Daphnia magna, chronic tox. to algae (for only non-polar narcotics)	concentration can be predicted
Class II	non-or weakly acidic phenols, aromatic amines and anilines, aliphatic primary amines, weakly basic pyridines	acute tox. to fish (phenol and primary aromatic amines)	a range can be predicted

21.		A recent evaluation by the US and EC of QSARs used by the US EPA OPPT has demonstrated good agreement between predicted and measured toxicity for *Daphnia* and fish (Ref. 12).

22.		A PNEC may be derived from QSAR estimates in combination with or without experimental data by the application of assessment factors, using values similar to those proposed for experimental data.

23.		QSAR can also be used to validate laboratory tests or to decide which further data are necessary.

Extrapolation Methods

EXCH\MANUAL\96-4-5.DOC/May 1996

24.	Extrapolation methods, which allow for different sensitivities of other, non-tested, species within ecosystems, can be used to estimate a PNEC when chronic toxicity data are available. Three extrapolation methods, which require at least laboratory data on the chronic toxicity of a chemical to five or more different aquatic species, are available through a computer program (Ref. 3).

(Semi-) Field Test

25.	If the results from testing using complex systems such as multi-species laboratory systems, microcosms, experimental ponds and field trials are available, a comprehensive assessment should be considered. Although there are no internationally agreed protocols for ecosystem tests up to now, multi-species tests have been developed by US EPA (Ref. 13 and 14) and guidance for multi-species studies has been developed by SETAC (Ref. 15 and 16). Criteria for judging the applicability of these results for estimation of a PNEC in the comprehensive assessment are recommended in Ref. 1.

### *4.5.4	Aquatic Effects Assessments Procedure for SIDS Chemicals*

A.	Evaluation of data used for the assessment

26.	Before conducting an effects assessment, data should be evaluated for their adequacy. For example, it should be affirmed that the test and effect concentrations did not exceed the solubility limit. Test results using solvents should carefully be examined. Other criteria are mentioned in Section 3 of Ref. 1 or Annex 1 to this document.

B.	Assessment possible when only SIDS data are available

Assessment Factors

27.	The experimental data on aquatic effects available from SIDS testing will include:
-- the fish acute test;
-- the *Daphnia* acute test;
-- the algal test (usually acute data); and, possibly
-- the *Daphnia* chronic test (in cases where there is concern about long-term effects in the aquatic environment)

28.	The recommended approach for estimating a PNEC with such a limited data set is to use assessment factors (see paragraphs 13-18). Table 3 shows data which would be obtained from the SIDS Dossiers and the assessment factors which could be applied. The approach to the selection of an assessment factor is described below, taking current discussions into consideration.

Table 3. Data in the SIDS Dossiers and Assessment Factors for Estimating an PNEC

Case	Data available	Range of Assessment factor
(a)	$EC_{50\ algae\ (72hr)}$ $EC_{50\ Daphnia\ (24\text{-}48hr\ acute\ test)}$ $LC_{50\ fish\ (96hr)}$	100 - 1000
(b)	$NOEC_{Daphnia\ (14\text{-}21d\ chronic\ toxicity\ test)}$ $NOEC_{algae\ (72hr)}$ $[NOEC_{fish\ (chronic\ toxicity\ test)}]$	10 - 100

[Note]
1. In case (a), all three acute data are included in the SIDS.
2. In case (b), $NOEC_{algae}$ is a SIDS element and $NOEC_{Daphnia}$ may also be included in the SIDS for certain chemicals. $NOEC_{fish}$ is available rarely.

29.   When only acute toxicity data in the SIDS are available, an assessment factor of between 1000 and 100 is applied to the lowest $L(E)C_{50}$ [i.e. case (a)]. A factor of 1000 is a conservative and protective factor and applied when only limited data are available, i.e. this value may be reduced to 100 if evidence is available to suggest that this may be a more appropriate factor. Such evidence would include:

    (1) availability of data from a wide variety of species including those which are considered to represent the most sensitive species;

    (2) information, from structurally similar compounds or QSAR, to suggest that the acute to chronic ratio is likely to be lower than that for many other compounds;

    (3) information to suggest that the chemical acts in a non-specific or narcotic manner, with little inter-species variation in toxicity; and

    (4) information to suggest that the chemical's release would be short-term or intermittent, and the chemical would not be persistent in the environment;

30.   When chronic toxicity data are available in addition to acute data, an assessment factor of between 100 and 10 is applied to the lowest NOEC [i.e. case (b)], taking the following situation into account:

    (1) If chronic NOEC is available from one or two species representing one or two trophic levels (i.e. fish, *Daphnia* or algae), a factor of 100 or 50 is applied to the lowest NOEC. In this case, a PNEC value derived from chronic data should be compared to that derived from the lowest acute data. It is then the lowest value that is compared to the PEC.

    (2) If chronic NOECs are available from three species representing three trophic levels (i.e. fish, *Daphnia* and algae), a factor of 10 is applied to the lowest NOEC. If there is convincing evidence that the most sensitive species has been tested, a factor of 10 may also be applied to the lowest NOEC from two species representing two trophic levels (i.e. fish and/or *Daphnia* and/or algae).

31.   Variation in the assessment factors applied should be clearly justified in the assessment report.

QSAR Approach

32.   In the SIDS Programme there is a preference for using measured data in effects assessment and in estimation of PNECs. However, if appropriate QSARs are available, they could be used and PNECs estimated by application of suitable assessment factors. A factor similar to that shown in Table 3 could be used. In this case the QSAR used and its reliability should clearly be indicated.

C.   Assessment Possible When Data Beyond SIDS are Available

Extrapolation Methods

33.   It is considered that extrapolation methods for the estimation of a PNEC in a refined assessment will not be an option for most HPV chemicals because chronic NOEC values for at least five different species are required.

(Semi-) Field Test

34.   The results of (semi-) field studies including short-term multi-species trials and long-term mesocosm trials are not thought to be available for many HPV chemicals. Where they are available and are considered appropriate, they provide the basis for a comprehensive effects assessment in combination with chronic toxicity data. The assessment factor to be used will need to be reviewed on a case-by-case basis.

D.   Consideration of Indirect Effects Assessment and Assessment on Benthic Organisms

35.   In addition to the effects assessments using pelagic aquatic organisms, assessments of indirect effects on birds and mammals and effects on benthic organisms (Ref. 4) could be done if information on the chemical suggests possible hazard. However, these are thought to be beyond the scope of the initial assessment of HPV chemicals with SIDS. Some methods mentioned in Ref. 1 and Ref. 7, namely an approach using BCF for indirect effects and the equilibrium partitioning method for benthic organisms, could be considered. However, assessments carried out using only data available in SIDS may be very uncertain.

4.5.5   Outcome of the Initial Assessment

36.   It should be stressed that all initial assessments in SIDS work should be extremely clear with regard to how they were developed, including approaches taken, any data used, and any assumptions made. Also data and estimations of exposure of a chemical which were used should be mentioned clearly. Examples in Ref. 1 are considered quite useful not only for understanding the assessment procedure but also for a model form of the report of the aquatic effects assessment.

37.   If the conclusions of the initial assessment of a chemical suggest a possible risk to aquatic organisms, a more precise assessment by further testing, as well as elaborating exposure assessment, could be considered and proposed. For example, in cases where an estimated PNEC was derived from the results of acute toxicity tests and assessment factors, doing chronic tests with appropriate species (e.g. most sensitive species in acute tests) would be considered as one of the possible further activities. Also if there is a possibility of indirect effects on birds and mammals or a possible hazard to benthic organisms, assessments on these could be considered and proposed for the next phase.

Annex 1

Criteria for Evaluation of Data

A.   Octanol-water Partition Coefficient

1.   The octanol-water partition coefficient (P_{ow}) should be examined carefully because it is very critical to the initial assessment of potential hazard. For example, determination of P_{ow} by the shake flask method is not suitable for highly hydrophobic chemicals (log P_{ow} > 5). For those chemicals, the slow stirring method or generator column method can be used. It should also be noted that log P_{ow} may not work for surfactants, polymers, inorganics, and organometalics.

B.   Bioaccumulation

2.   Data on bioaccumulation are principally used only for evaluating indirect effects of a chemical. They could be obtained through a QSAR equation by using P_{ow} as well as by experiment. It should be noted that simple bioaccumulation QSARs often cannot predict the concentrations of extremely hydrophobic chemicals under field conditions. If more than one bioconcentration factor (BCF) is available for the same species, the geometric mean for the species could be used; however, the test concentration should be taken into account. If BCFs are available for two or more species, the highest factor for a trophic level should be used. BCFs for algae, daphnids and fish should not be mixed and should be kept separate for each trophic level.

C.   Aquatic Toxicity

3.   Results of chronic toxicity tests are preferred for chemicals that have been shown to bioconcentrate/bioaccumulate or are potentially bioaccumulative. For some of these chemicals, a 96-hour exposure in acute tests may not be sufficiently long. In any case, the water solubility of the test substance must be measured or predicted and the solubility limit must be compared to effect concentrations (e.g. 96h-LC_{50}).

4.   Interpretation of the data is important. For example, the key aspects of the study methods which affect study quality, such as measured or nominal concentration, control response, use of "insensitive" species, and water quality values, should be considered. Endpoints which have direct ecological relevance (e.g. survival, growth, reproduction) should be given more weight than other endpoints (e.g. biochemical parameters). Consideration of test species is also important; for example, in those cases where chronic studies have not been done with the most sensitive species in the acute tests.

5.   If several toxicity data are available for one test species, the following rules may be applied:

--   If these data are based on the same effect parameter (endpoint) and the same time period, the geometric mean value should be used.
--   If different effect parameters or different exposure times within the same species are used, only the lowest value from the longest test time should be used taking into account the importance of the endpoints and the exposure periods in the various tests.
--   Data used for the extrapolation methods as described in Section 5 of Ref. 1 are restricted to NOEC values or geometric mean MATC values [MATC = $(NOEC \times LOEC)^{1/2}$]. Results of chronic tests reporting only the lowest test concentration (LOEC) might be included if they are converted to estimated NOEC values appropriately. For example, the equation: NOEC= LOEC/2 could be used in several cases. Regression methods also can be used for estimation.

Annex 2

References

1. OECD Environment Monograph N0. 92, Guidance Document for Aquatic Effects Assessment, 1995

2. OECD Environment Monograph No. 58, Report of the OECD Workshop on Quantitative Structure Activity Relationships (QSARs) in Aquatic Effects Assessment, 1992

3. OECD Environment Monograph No. 59, Report on the OECD Workshop on the Extrapolation of Laboratory Aquatic Toxicity Data to the Real Environment, 1992

4. OECD Environment Monograph No. 60, Report on the OECD Workshop on the Effects Assessment of Chemicals in Sediment, 1992

5. Technical Guidance Documents in Support of the Commission Directive 93/67/EEC on Risk Assessment for New Substances and the Commission Regulation (EC) N° 1488/94 on Risk Assessment for Existing Substances (in print)

6. Technical Report No. 51, Environmental Hazard Assessment of Substances, European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), January 1993

7. Estimation of "concern levels" for concentrations of chemical substances in the environment, US EPA, OTS, Health and Environmental Review Division, Environmental Effects Branch, 1984

8. Heger, W., S. M. Jung, S. Martin, H. Peter; Acute and Prolonged Toxicity to Aquatic Organisms of New and Existing Chemicals and Pesticides. Chemosphere Vol. 31, No. 2, 2707-2726, 1995

9. Estimating Toxicity of Industrial Chemicals to Aquatic Organisms using Structure Activity Relationships, OTS, US EPA, 1988

10. ASTER (Assessment Tools for the Evaluation of Risk), Scientific Outreach Program, US EPA, Environmental Research Laboratory-Duluth, 1991

11. ECOSAR (A Computer Program for Estimating the Ecotoxicity of Industrial Chemicals Based on Structure Activity Relationships.), OPPT, US EPA, 1994

12. OECD Environmental Monograph No. 88, US EPA/EC Joint Project on the Evaluation of (Quantitative) Structure Activity Relationships, 1994

13. Federal Register Vol. 52, No. 187, Sept. 28, 1987, pp 36334 to 36371.

14. Methods for Ecological Toxicology: A Critical Review of Laboratory Multispecies Tests. A.S. Hammons, Ed. Ann Arbor Science Publications, Inc./The Butterworth Group, 1981.

15. Guidance Document on Testing Procedures for Pesticides in Freshwater Mesocosms, Society of Environmental Toxicology and Chemistry (SETAC) - Europe, 1991

16. Workshop Report (Workshop on Aquatic Microcosms for Ecological assessment of Pesticides, Wintergreen, Virginia, 6 - 12 October 1991), SETAC, February 17, 1992